



# Mediating role of post-traumatic growth in the relationship between inadequate disaster recovery and mental health outcomes: long-term evidence from the Wenchuan earthquake

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## ABSTRACT

**Background:** The mental health outcomes from disasters have aroused great concern worldwide, yet few studies incorporate a long-term disaster recovery perspective. Evidence has also emerged about the importance of the social determinants of mental health, but aspects of recovery including disruptions to livelihoods and social networks remain relatively understudied.

**Objective:** This study utilizes cognitive adaptation theory to examine the long-term relationship between inadequate disaster recovery and mental health outcomes while considering domains of post-traumatic growth (PTG) as mediators.

**Methods:** A cross-sectional study was conducted among 1369 adult survivors of the 2008 Wenchuan earthquake. Correlation analyses and multivariable regression analyses examined the association between inadequate disaster recovery and mental health outcomes, while parallel multiple mediator models and structural equation model explored the mediating role of PTG among these relationships.

**Results:** 52.2% and 8.1% of the respondents reported inadequate recovery on livelihood and social ties, respectively. Inadequate disaster recovery was associated with higher levels of PTSD and depressive symptoms, and this association was partially mediated by PTG. Lower reported PTG on the interpersonal relationship and new possibilities domains mediated the association between inadequate livelihood recovery on PTSD and depressive symptom severity, and enhanced personal strength mediated the association between inadequate social ties recovery on these symptoms.

**Conclusion:** Enhancing disaster recovery is essential for mental health protection, and PTG may be a valuable starting point in cognitive therapy to protect against stress responses after trauma.

## Papel Mediador del Crecimiento Postraumático en la Relación entre la Recuperación Inadecuada después de un Desastre y los Resultados en Salud Mental: Evidencia a Largo Plazo del Terremoto de Wenchuan

**Antecedentes:** Los resultados de salud mental de los desastres han despertado una gran preocupación en todo el mundo, sin embargo, pocos estudios incorporan una perspectiva de recuperación de desastres a largo plazo. También ha surgido evidencia sobre la importancia de los determinantes sociales de la salud mental, pero los aspectos de la recuperación, incluidas las alteraciones de los medios de subsistencia y las redes sociales, siguen siendo relativamente poco estudiados.

**Objetivo:** Este estudio utiliza la teoría de la adaptación cognitiva para examinar la relación a largo plazo entre la recuperación inadecuada ante desastres y los resultados de salud mental, al tiempo que considera los dominios del crecimiento postraumático (DCP) como mediadores.

**Métodos:** Se realizó un estudio transversal entre 1369 adultos sobrevivientes del terremoto de Wenchuan del 2008. Los análisis de correlación y los análisis de regresión multivariado examinaron la asociación entre la recuperación inadecuada a desastres y los resultados en salud mental, mientras que los modelos paralelos de múltiples mediadores y los modelos de ecuaciones estructurales exploraron el papel mediador de la DCP entre estas relaciones.

**Resultados:** El 52,2% y el 8,1% de los encuestados informaron una recuperación inadecuada de los medios de subsistencia y los lazos sociales, respectivamente. La recuperación de desastres inadecuada se asoció con niveles más altos de TEPT y síntomas depresivos, y esta asociación fue parcialmente mediada por DCP. Un menor DCP reportado sobre la relación interpersonal y los nuevos dominios de posibilidades mediaron la asociación entre la recuperación inadecuada de los medios de subsistencia en el TEPT y la gravedad de los síntomas depresivos, y el aumento de la fuerza personal medió la asociación entre la recuperación inadecuada de los lazos sociales en estos síntomas.

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## PALABRAS CLAVE

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## 关键词

灾后恢复; 创伤后应激障碍; 抑郁; 创伤后成长; 中介作用

## HIGHLIGHTS

- Disaster recovery is long-term issue, which should be enhanced in further disaster reconstruction programmes.
- Poor disaster recovery associates with higher levels of mental health symptoms.
- PTG mediates the relationship between disaster recovery and mental health symptoms.

**Conclusión:** Mejorar la recuperación ante desastres es esencial para la protección de la salud mental, y la DCP puede ser un punto de partida valioso en la terapia cognitiva para proteger contra las respuestas al estrés después de un trauma.

### 创伤后成长在灾后恢复与精神健康之间的中介作用：基于汶川地震的长期研究

**背景:** 自然灾害后的心理健康议题在世界范围内引起广泛关注，但已有研究鲜少从长期灾后恢复的角度来开展心理健康研究。已有研究对心理健康的影响因素进行了诸多探讨，但是，灾后生计恢复，社会网络恢复与心理健康的关系仍未得到全面讨论。

**目标:** 本研究旨在探索灾后恢复不足与灾民心理健康的关系，并在认知适应理论下讨论不同维度的创伤后成长在上述关系中的中介作用。

**方法:** 本研究基于对1369位汶川地震成年幸存者的横截面研究，借用相关分析与多变量回归对灾后恢复不足与心理健康后果的关系进行检验，使用单步多重中介模型和结构方程模型对创伤后成长在上述关系中的中介作用进行分析。

**结果:** 本研究发现分别有52.2%和8.1%的灾民表现出生计恢复不足与社会网络恢复不足。两种维度的灾后恢复不足都显著关联于更高层次的创伤后应激性障碍和抑郁症状。具体来说，人际关系与发展新机会上的较低水平成长在一定程度上遮掩了由生存能力恢复不足对心理健康带来的负面效应，而个人增能的强化在一定程度上抵消了社会网络恢复不足对心理健康带来的负面影响。

**结论:** 灾后恢复水平的提升对心理健康保护具有重要作用，而创伤后成长有可能成为认知疗法的新视角，用来缓解创伤后的压力性反应。

## 1. Introduction

On 12 May 2008, a devastating magnitude 8.0 earthquake struck Wenchuan, a small county in the Sichuan province of Southwest China. Studies estimated that the Wenchuan earthquake forced over 15 million residents to evacuate, left at least 5 million people homeless, and resulted in a total of 87,000 dead or missing residents (State Council Information Office of China [SCIOC], 2008). In the aftermath of this traumatic event, the Chinese government, together with non-governmental organizations (NGOs), dedicated large quantities of resources to disaster reconstruction (Huang, Zhou, & Wei, 2011) and conducted a series of programmes to help victims return to their pre-disaster lives. Three years later, most of these programs concluded in hard-hit areas in Wenchuan, after 95% of the county's fundamental facilities were rebuilt (Xu & Lu, 2012).

Disaster recovery could be regarded as either a process of pursuing reconstruction, or the endpoint following the struggle with adversities (Phillips, 2009). In this study, we define disaster recovery as the extent to which survivors regained their pre-disaster lives. Traditional studies focused disaster recovery on physical concerns, but have evolved to incorporate a multidimensional and social-oriented focus during the past decade (Han, 2014; Mayer, 2019). In particular, under such disaster-specific contexts as household damage and evacuation status, social ties (i.e., relationships with spouse, family members, friends, relatives, and neighbours) became a crucial issue in disaster recovery evaluations (Lee, Sadri, Ukkusuri, Clawson, & Seipel, 2019). Regretfully, most studies remain limited in their assessment of disaster recovery, and focus mostly on livelihood items such as income or housing conditions (Wang, Zou, & Li, 2015; Wei & Han, 2018).

However, we propose an expansion of the assessment of social ties because it affects the nuance between vulnerability and resilience, and predicts mental health outcomes following trauma (Bolin & Kurtz, 2018; Hall, Murray, Galea, Canetti, & Hobfoll, 2015). Also, bridging and bonding interpersonal relationships are beneficial in bringing new livelihood opportunities, which would improve post-disaster outcomes (Naithani & Saha, 2020). Therefore, to better evaluate long-term disaster recovery in the wake of the Wenchuan earthquake, this study's first aim is to discuss disaster recovery on livelihood and social ties, respectively.

Our second aim is to investigate the relationship between disaster recovery and mental health outcomes. As two of the most commonly experienced mental health disorders after natural disasters, PTSD and depression have aroused public health concern (North & Pfefferbaum, 2013; Tang et al., 2017). Most trauma studies concur that risk factors associated with PTSD and depression include gender, age, education, traumatic exposure, social support, and economic status (Canino, Bravo, Rubio-Stipec, & Woodbury, 1990; Fu et al., 2019), but less consideration goes to disaster recovery (Goldmann & Galea, 2014). Evidence from Hurricane Katrina showed higher levels of distress among women who viewed their lives as having been disrupted by trauma (Giarratano, Savage, Rick, Harville, & de Mendoza, 2012). In contrast, expanded disaster recovery was shown to significantly reduce the risk of both mental health sequelae post-Katrina (Abramson, Stehling-Ariza, Garfield, & Redlener, 2008) and psychiatric disorders following the 1988 Spitak earthquake in Armenia (Goenjian, Khachadourian, Armenian, Demirchyan, & Steinberg, 2018). However, the majority of existing disaster recovery studies have been conducted in western countries (Abramson

et al., 2008; Goenjian et al., 2018), with fewer examinations within the Chinese context. Due to different risk preparation strategies and disaster reconstruction policies, there are differences in recovery trajectories across countries (Alcayna, Bollettino, Dy, & Vinck, 2016). Moreover, in a Chinese society where the content and function of survivor guilt differs from that in Western countries (Tangey & Dearing, 2002), the association between disaster recovery and mental health would also be affected.

Furthermore, we aim to investigate the mechanism through which inadequate disaster recovery may relate to mental health outcomes via PTG. For most survivors, inadequate disaster recovery becomes a chronic stressor after the onset of trauma (Murphy, 1989). According to Cognitive Adaptation Theory (Taylor, 1983), people have a self-protective cognitive bias for seeing positive aspects of negative experiences when they encounter threats. PTG refers to the positive legacy of experiencing trauma (Morris, Shakespeare-Finch, & Scott, 2007). It could be conceptualized as a cognitive appraisal (Taylor, 1983) or as an interpretative process (Filipp, 1999). We hypothesized that PTG would have a mediating role for the reasons: Through a direct and proximal process, inadequate disaster recovery may provide a means of cognitive and affective exposure, facilitate an alternative set of behaviours to negative strategies that may elicit related mental health outcomes (Rachman, 1980). However, positive cognitive re-appraisal indicated by thinking of PTG may reduce survivors' willingness to approach their potential distressing response to disaster recovery, and will thereby alter the pattern of cognitive-emotional processing (Joseph & Linley, 2005). Thus, PTG is hypothesized to mediate the relationship between inadequate disaster recovery and mental health outcomes.

In addition, due to the complex cognitive appraisal process involved in PTG, whether it serves as a mediator of the relationship between inadequate disaster recovery and mental health outcomes remain unclear. As the two-component PTG model noted (Zoellner & Maercker, 2006), PTG has a functional and self-transcending side as well as a dysfunctional and illusory side (Taylor, Kemeny, Reed, Bower, & Gruenewald, 2000). The constructive side of PTG is helpful for people to counterbalance emotional distress while the self-deceptive side potentially correlates with self-consolidation, which is risky for mental health (Taylor & Brown, 1988; Zoellner & Maercker, 2006). Moreover, PTG as a multidimensional construct, is comprised of five domains (Tedeschi & Calhoun, 2004), so the mediating role of different PTG dimensions may be distinct. Different types of growth may be associated with varying patterns of traumatic information accommodation and social environment factors (Joseph & Linley, 2005); therefore, we might expect that mediating effects will differ by growth dimensions.

In a summary, this study aimed to: (1) evaluate the level of disaster recovery 8 years after the Wenchuan earthquake; (2) explore the relationship between inadequate disaster recovery and mental health outcomes (PTSD, depressive symptoms); and (3) identify whether and how domains of PTG mediate this relationship. Our first hypothesis proposes that survivors with inadequate disaster recovery, whether related to their livelihood or social ties, report more mental health symptoms than those who do not have these impairments. Our second hypothesis concerns the mediating role of PTG. We expect that PTG suppresses the negative effect of inadequate disaster recovery on mental health. Our third exploratory hypothesis is that the subscales of PTG will have varying mediating roles in the above association.

## 2. Methods

### 2.1. Study design and participants

Data in this study were obtained from a community-based, cross-sectional survey among adult Wenchuan earthquake survivors. In February 2016, participants were recruited from two sites in severely affected areas: the township of Yongan in Beichuan city and the township of Guangji in Mianzhu city. Yongan and Guangji were carefully selected because both sites suffered severe destruction during the Wenchuan earthquake, yet to somewhat different degrees. Yongan is located 115.7 km from the earthquake's epicentre and over 90% of its buildings were damaged during the event. Guangji is 58.3 km away from the epicentre and nearly 96% of its buildings were destroyed by the earthquake (Chan et al., 2011; China Central Television [CCTV], 2008).

Participants were selected via a combined multistage systematic sampling and convenience sampling design. In the first stage, 12 of 29 villages in Yongan and Guangji were randomly selected. Then, households were systematically selected as the basic unit of the entire survey with village registration information. However, in selected villages where many houses were vacant and registration information was inapplicable, a non-random sampling method was adopted as a supplement. Finally, from each selected household, one member aged 16 years or over participated in this survey, resulting in a sample size of 1369 respondents.

During the survey, face-to-face interviews were conducted by 22 trained college students from Mianyang Normal University. To avoid misunderstandings, all interviews were conducted in Mandarin Chinese, accompanied by local dialects and native languages. All interviewees were thoroughly trained before the survey and were familiar with all contents of the research. All interviewees were informed of their right of refusal and gave verbal consent before the interview began. During the interview, trained students read the questions aloud to the participants, provided additional explanations if

needed, and then wrote down respondents' answers on the questionnaire directly. The study protocol was approved by the Institutional Review Board of Tongji Medical College, Huazhong University of Science and Technology.

## 2.2. Measures

**Probable Symptomatic PTSD** was evaluated via the Impact of Events Scale-Revised (IES-R), which has been widely used in traumatic stress research (Weiss & Marmar, 1997) and found to have stable psychometric properties (Creamer, Bell, & Failla, 2003). The Chinese version of the IES-R was examined and determined to have satisfactory psychometric properties (Chen et al., 2007). In this study, the IES-R included a total of 22 items to measure three major symptom clusters of PTSD after the Wenchuan earthquake: Intrusion, Avoidance, and Hyper-arousal (Qu et al., 2012). The participants were asked to describe the frequency of their distress from 0 to 4, representing not at all, seldom, sometimes, and often, respectively. The PTSD total score was calculated as the average of response across items, with higher scores indicating greater PTSD. The internal consistency coefficient of the whole scale in this study was 0.93. To estimate the prevalence of PTSD with IES-R, this study adopted the mean score of 2.0 across all items as the cut-off point, consistent with earlier studies (Chan et al., 2011).

**Depressive symptoms** were assessed via the Chinese edition of the Centre for Epidemiologic Studies Depression Scale (CES-D) (Wang, 1999). This scale includes 20 depressive symptoms, and respondents were asked to rank the frequency of these symptoms on a scale of 0 to 3 points, with higher scores representing more depressive symptoms. The Chinese edition of the CES-D has been widely used in community-based studies to screen probable major depression, and has good validity and reliability across all age groups (Zhang et al., 2010). In this study, the internal consistency coefficient of the CES-D was 0.88. To estimate the prevalence of depression among adult Wenchuan earthquake survivors, this study used a cut-off point of 21 (Cheng & Chan, 2005), which was shown to be effective in predicting depression in China.

**Inadequate Disaster Recovery** was assessed via a self-designed questionnaire. Items were drawn from existing studies (Dynes & Quarantelli, 2008; Passerini, 2000). A total of 7 items were included, comparing respondents' present situation with their pre-earthquake situation on a 5-point scale ranging from 0 (much better) to 4 (much worse). The total score was summed, and higher scores represent higher levels of inadequate disaster recovery. Disaster recovery consists of two conceptually different dimensions, namely livelihood recovery, and social ties recovery (Phillips, 2009). Principle factor analysis

(maximum likelihood) with oblique rotation was conducted to examine if the two dimensions could be meaningfully distinguished from each other. Results indicated that two factors explained 62.55% of the variance, and both had an Eigenvalue over 1. Three items loaded significantly on the livelihood factor (a: physical health; b: family income; c: the ability to conduct daily activities), with loading of 0.602, 0.795, and 0.768, respectively. The other 4 items loaded on the social ties factor (d: family relationship; e: marital status; f: relationships with relatives/friends; and g: relationships with neighbours), with loading of 0.778, 0.718, 0.734, and 0.722. This measurement was found to have good and stable properties (Floyd & Widaman, 1995), and the internal reliability was 0.783 in general, 0.618 for inadequate livelihood recovery, and 0.805 for inadequate social ties recovery. Two dimensions of inadequate disaster recovery were highly correlated, and were also correlated to PTSD and depressive symptoms. However, they were associated with different subscales of PTG (see Table 2). Additionally, a score of score  $\geq 3$  on an item indicated a lack of recovery for that dimension.

**PTG** was assessed with the Posttraumatic Growth Inventory (PTGI) (Tedeschi & Calhoun, 1996), a validated scale widely used to investigate the positive consequences of traumatic events. The initial version of the PTGI was designed in the context of western settings and consists of 21 items within 5 major domains: relating to others (7 items), new possibilities (5 items), personal strength (4 items), spiritual changes (2 items), and appreciation of life (3 items). Participants were invited to respond on a 6-point scale ranging from 0 (no change happens) to 5 (changed completely). In this study, the spiritual changes domain was excluded due to low reliability (Cronbach's  $\alpha = 0.472$ ). Items were summed to create a total score, with higher scores representing greater PTG. The PTGI previously showed good internal and test-retest reliability within Chinese samples (Jin, Xu, & Liu, 2014), and in this study, the internal reliabilities for relating to others, new possibilities, personal strength, and appreciation of life were 0.85, 0.76, 0.78, and 0.69, respectively.

**Confounding Variables** in this study included sociodemographic characteristics: location (Yongan/Guangji), gender (male/female), age, marital status (with a spouse/single), self-perceived income (poor/middle/rich), and years of education, all of which were believed to be associated with mental health by previous studies (Guo, Fu, Xing, Qu, & Wang, 2017; Tang et al., 2017). Mental illness prior to the earthquake (Yes/No) and trauma experiences after the earthquake (Yes/No) were also considered as covariates, to better evaluate the association between the Wenchuan earthquake on mental health.



### 2.3. Statistical analyses

Descriptive statistics were calculated for all main variables, and for covariates in the total sample and the Yongan and Guangji samples. Bivariate correlation analyses were conducted to explore the relationship between the main variables. Four multivariable linear regressions were used to explore the relationships of inadequate livelihood recovery and mental health (PTSD, depressive symptoms), and associations between social ties and PTSD or depressive symptoms, respectively. In order to examine whether and how domains of PTG mediate the relationship between inadequate disaster recovery (livelihood and social ties as two separate independent variables) and mental health outcomes (PTSD and depressive scores as two separate dependent variables), we constructed four parallel multiple mediator models (Hayes, 2012). Sobel tests were conducted and an explanation of direct, indirect, and total effects was presented. Furthermore, given the coexistence of two independent variables, as well as two outcome variables, we estimated a Structural Equation Model (SEM) as a robustness test for the mediation mechanisms found by parallel multiple mediator models (Fang, Wen, & Wu, 2018). Parallel multiple mediator models were constructed by SPSS 22.0 (via the PROCESS macro, 2014) and all other statistical analyses were conducted via Stata 14 (Stata Statistical Software: Release 14, 2015).

## 3. Results

### 3.1. Descriptive analyses of the sample by location

As shown in Table 1, a total of 1369 respondents participated in this study, distributed in roughly equal number between Guangji ( $n = 677$ , 49.5%) and Yongan ( $n = 692$ , 50.5%). As we noted before, sociodemographic characteristics were similar in Guangji and Yongan, with the majority of the population being women, married, and earning a mid-level income. The average age in the Guangji sample (Mean = 55.27, SD = 15.12) was slightly older than in Yongan (Mean = 53.38, SD = 16.64), but the educational level was not significantly different between the two areas. In Guangji, the prevalence of pre-disaster mental illness and post-earthquake trauma experiences were 19.5% ( $n = 132$ ) and 18.9% ( $n = 127$ ), while the corresponding prevalence in Yongan were 17.3% ( $n = 120$ ) and 19.4% ( $n = 133$ ), respectively.

As both areas were severely damaged in the earthquake, their levels of disaster recovery were similar, except for the prevalence of inadequate social ties recovery. In Yongan, about 9.8% ( $n = 68$ ) of the respondents reported unrecovered social ties, which was slightly more than that in Guangji ( $n = 43$ , 6.4%). Depressive symptoms presented no significant differences between regions, yet the prevalence and levels of PTSD were lower in Guangji ( $n = 57$ , 8.4%; Mean = 0.81, SD = 0.79) versus in Yongan ( $n = 104$ , 15.0%; Mean = 1.03, 0.88). In general, both two

areas reported a relatively low levels of PTG, but the level of increased personal strength in Guangji (Mean = 9.66, SD = 4.87) was higher than that in Yongan (Mean = 8.62, SD = 4.51). More details are presented in Table 1.

### 3.2. Relationship between inadequate disaster recovery, PTG, and mental health

Table 2 presents results of the bivariate correlation analyses, which implies a correlation between inadequate disaster recovery and PTG (including all four PTG dimensions), as well as PTSD and depressive symptoms. There was a significant correlation between inadequate livelihood recovery and inadequate social ties recovery ( $r = 0.13$ ,  $p < 0.001$ ). Both livelihood recovery and social ties recovery were positively associated with PTSD and depressive symptoms, suggesting that inadequate disaster recovery was related to a higher risk of mental health outcomes. Inadequate livelihood recovery was negatively correlated to a *better relationship with others* ( $r = -0.12$ ,  $p < 0.001$ ) and *identification of new possibilities* ( $r = -0.18$ ,  $p < 0.001$ ), whereas inadequate social ties recovery was positively correlated with increased *personal strength* ( $r = 0.03$ ,  $p < 0.001$ ) and more *appreciation of life* ( $r = 0.01$ ,  $p < 0.001$ ).

As shown in Table 3, inadequate livelihood recovery was related to higher levels of PTSD ( $\beta = 0.12$ , 95% CI = 0.07, 0.16) and depressive symptoms ( $\beta = 0.19$ , 95% CI = 0.13, 0.24). And inadequate social ties recovery was also related to higher levels of PTSD ( $\beta = 0.07$ , 95% CI = 0.02, 0.12) and depressive symptoms ( $\beta = 0.08$ , 95% CI = 0.02, 0.13). With regard to domains of PTG, their associations with mental health outcomes varied. *Better relating to others* and *identification of new possibilities* were related to higher levels of PTSD and depressive symptoms; however, enhanced *personal strength* and *appreciation of life* were related to lower depressive symptoms. In general, females, those with trauma experiences after the earthquake, people with lower income, and lower education levels, had greater depressive and PTSD symptom severity (See Table 3).

### 3.3. PTG as a mediator in the relationship between inadequate disaster recovery and mental health

As Table 4 shows, PTG partially mediates the associations between inadequate disaster recovery and PTSD/depressive symptoms. After controlling for covariates (see Table 4), inadequate livelihood recovery was found to be directly associated with higher levels of PTSD ( $\beta = 0.13$ , 95% CI = 0.08, 0.18) and depressive symptoms ( $\beta = 0.19$ , 95% CI = 0.14, 0.24). However, the PTG domain *better relating to others* and *identification of new possibilities* buffered these associations. The direct effects of inadequate social ties recovery on PTSD

**Table 1.** Descriptive characteristics of the sample by area division.

Characteristics		Total (n = 1369)		Guangji (n = 677)		Yongan (n = 692)		Sig
		N	%	N	%	N	%	
PTSD	Yes	161	11.8	57	8.4	104	15.0	<0.001***
	No	1208	88.2	620	91.6	588	85.0	
Depression	Yes	340	24.8	162	23.9	178	25.7	.453
	No	1029	75.2	515	76.1	514	74.3	
Inadequate livelihood recovery	Yes	715	52.2	364	53.8	351	50.7	.279
	No	654	47.8	313	46.2	341	49.3	
Inadequate recovery on physical health	Yes	609	44.5	317	46.8	292	42.2	.092
	No	760	55.5	360	53.2	400	57.8	
Inadequate recovery on family income	Yes	273	19.9	135	19.9	138	19.9	1.000
	No	1096	80.1	542	80.1	554	80.1	
Inadequate recovery on daily activities	Yes	118	8.6	50	7.4	68	9.8	.123
	No	1251	91.4	627	92.6	624	90.2	
Inadequate social ties recovery	Yes	111	8.1	43	6.4	68	9.8	.022*
	No	1258	91.9	634	93.6	624	90.2	
Inadequate recovery on family relationship	Yes	53	3.9	22	3.2	31	4.5	.264
	No	1316	96.1	655	96.8	661	95.5	
Inadequate recovery on marital status	Yes	44	3.2	18	2.7	26	3.8	.285
	No	1325	96.8	659	97.3	666	96.2	
Inadequate recovery on friendship/with relatives	Yes	32	2.3	12	1.8	20	2.9	.211
	No	1337	97.7	665	98.2	672	97.1	
Inadequate recovery on relationships with neighbours	Yes	35	2.6	15	2.2	20	2.9	.495
	No	1334	97.4	662	97.8	672	97.1	
Gender	Female	725	53.4	346	51.2	379	55.7	.103
	Male	632	46.6	330	48.8	302	44.3	
Marital status	Single	234	17.4	105	15.7	129	19.2	.098
	Married	1109	82.6	565	84.3	544	80.8	
Income	Low	381	28.1	202	30.0	180	26.3	.344
	Mid	861	63.4	417	61.9	444	64.9	
	High	115	8.5	55	8.1	60	8.8	
Psychological problems before earthquake	Yes	252	18.4	132	19.5	120	17.3	.329
	No	1117	81.6	545	80.5	572	82.7	
Severe trauma experiences after earthquake	Yes	260	19.1	127	18.9	133	19.4	.836
	No	1098	80.9	546	81.1	552	80.6	
		Mean	SD	Mean	SD	Mean	SD	Sig
PTSD scores		0.92	0.84	0.81	0.79	1.03	0.88	<0.001***
Depressive scores		14.78	9.14	14.34	9.05	15.20	9.21	.081
PTG scores		39.63	18.15	39.67	18.44	39.59	17.88	.934
Better relating to others		15.16	7.73	14.94	7.83	15.37	7.63	.306
Identification of new possibilities		8.10	5.27	7.99	5.28	8.20	5.26	.452
Personal strength		9.14	4.72	9.66	4.87	8.62	4.51	<0.001***
Appreciation of life		7.24	3.47	7.08	3.56	7.39	3.37	.092
Inadequate livelihood recovery scores		8.44	2.08	8.53	2.06	8.36	2.08	.117
Inadequate social ties recovery scores		10.05	2.19	10.14	2.18	9.96	2.20	.130
Age		54.34	15.90	55.27	15.12	53.38	16.64	.033*
Years of education		6.33	3.16	6.35	3.16	6.31	3.17	.804

Notes: SD: Standard deviation, Sig: value of significance tests, \*\*\*  $P < 0.001$ , \*\*  $P < 0.01$ , \*  $P < 0.05$ , F-tests and t-tests were conducted to report the significance of differences between Yongan sample and Guangji sample.

**Table 2.** Intercorrelations between main variables in this study (N = 1369).

	V1	V2	V3	V4	V5	V6	V7	V8
V1	1							
V2	0.13**	1						
V3	-0.12**	-0.03	1					
V4	-0.18**	-0.02	0.66**	1				
V5	-0.10	0.03**	0.68**	0.68**	1			
V6	-0.05	0.01**	0.59**	0.54**	0.58**	1		
V7	0.12**	0.11**	0.26**	0.22**	0.15**	0.18**	1	
V8	0.26**	0.24**	-0.03	-0.03	-0.14**	-0.09**	0.43**	1

Notes: V1 and V2 were independent variables, V1: Inadequate livelihood recovery, V2: Inadequate social ties recovery. V3-V6 were mediators, V3: Better relating to others, V4: Identification of new opportunities, V5: Personal strength, V6: Appreciation of life. V7-V8 were dependent variables, V7: PTSD scores, V8: Depressive scores, \*\*: Correlation was significant on 0.01 level (two-tail test). Relationships between covariates were not presented due to space limits.

( $\beta = 0.07$ , 95%CI = 0.02, 0.12) and depressive symptoms ( $\beta = 0.10$ , 95%CI = 0.05, 0.15) were smaller than on

livelihood recovery. Associations between inadequate social ties recovery and mental health outcomes were mediated by *personal strength*, whose indirect effects were  $-0.01$  (95%CI =  $-0.03$ ,  $-0.01$ ) for PTSD and  $-0.03$  (95%CI =  $-0.05$ ,  $-0.01$ ) for depressive symptoms.

Results presented in Figure 1 supported the mediation mechanisms found by parallel multiple mediation models. This SEM fit the data well with a  $\chi^2/df = 3.038$ , RMSEA = 0.039, SRMR = 0.022, CFI = 0.986, TLI = 0.966,  $pclose = 0.936$  and AIC = 42,208.95, BIC = 42,577.81. The Chi-square test result for this SEM was significant ( $p < 0.001$ ); however, this is believed to be acceptable (Wen, Hau, & Marsh, 2004). The direct effect of inadequate livelihood recovery to mental health outcomes remained robust, whereas those from social ties recovery lost significance. We validated the findings that inadequate livelihood recovery was associated with

**Table 3.** Multivariate regressions of PTSD and depressive scores on inadequate disaster recovery, PTG and other covariates (N = 1369).

	PTSD scores				Depressive scores			
	Model 1		Model 2		Model 1		Model 2	
	Stand. beta	95%CI	Stand. beta	95%CI	Stand. beta	95%CI	Stand. beta	95%CI
<b>Inadequate recovery</b>								
Livelihood	0.12	0.07–0.16 ***			0.19	0.13–0.24***		
Social ties			0.07	0.02–0.12***			0.08	0.02–0.13**
<b>PTG</b>								
Better relating to others	0.22	0.14–0.29***	0.22	0.14–0.30***	0.10	0.02–0.17**	0.10	0.02–0.18*
Identification of new possibilities	0.19	0.12–0.27 ***	0.18	0.10–0.25***	0.18	0.10–0.26***	0.15	0.07–0.23***
Personal strength	–0.07	–0.14–0.01*	–0.07	–0.15–0.01**	–0.22	–0.30–0.14***	–0.22	–0.30–0.14***
Appreciation of life	0.01	–0.05–0.08	0.02	–0.04–0.08	–0.09	–0.15–0.02**	–0.08	–0.14–0.01*
<b>Location</b>								
Yongan (reference)								
Guangji	0.12	0.07–0.17 ***	0.12	0.07–0.17***	0.01	–0.04–0.06	0.01	–0.04–0.06
<b>Gender</b>								
Female (reference)								
Male	–0.15	–0.20–0.10 **	–0.16	–0.21–0.11***	–0.10	–0.15–0.05***	–0.12	–0.17–0.07***
<b>Marital Status</b>								
Single (reference)								
Married	0.06	0.01–0.11 *	0.06	0.01–0.11*	–0.10	–0.15–0.05***	–0.10	–0.15–0.05***
<b>Prior Psychological problems</b>								
No (reference)								
Yes	0.03	–0.02–0.07	0.03	–0.02–0.07	0.04	–0.01–0.09	0.04	–0.01–0.09
<b>Post earthquake trauma experience</b>								
No (reference)								
Yes	0.11	0.06–0.16 ***	0.13	0.08–0.18***	0.14	0.09–0.19***	0.16	0.11–0.21***
<b>Income</b>								
Low (reference)								
Mid	–0.11	–0.17–0.06 ***	–.13	–0.19–0.08***	–0.17	–0.23–0.11***	–0.20	–0.26–0.15***
High	–0.12	–0.17–0.06 ***	–.14	–0.19–0.08***	–0.10	–0.16–0.05***	–0.13	–0.19–0.08***
<b>Age</b>	0.10	0.04–0.16 **	0.10	0.03–0.16**	0.06	0.01–0.13*	0.06	–0.01–0.13
<b>Years of education</b>	–0.15	–0.21–0.08***	–0.15	–0.21–0.09***	–0.16	–0.22–0.10***	–0.17	–0.23–0.10***

Notes: Stand. Beta: Standardized beta, CI: Coefficient interval, \*\*\*  $P < 0.001$ , \*\*  $P < 0.01$ , \*  $P < 0.05$ . Model 1 focused on inadequate livelihood recovery, Model 2 focused on inadequate recovery on social ties, and all variables have been standardized.

**Table 4.** Effect composition of the associations from inadequate disaster recovery to mental disorders by PTG mediation.

	PTSD scores				Depressive scores			
	Effect	Boots SE	Boot LLCI	Boot ULCI	Effect	Boots SE	Boot LLCI	Boot ULCI
<b>Inadequate livelihood recovery</b>								
Total effect	0.07	0.03	0.02	0.13	0.16	0.03	0.11	0.21
Direct effect	0.13	0.03	0.08	0.18	0.19	0.03	0.14	0.24
Indirect effect	–0.05	0.01	–0.08	–0.03	–0.03	0.01	–0.04	–0.02
• Better relating to others	–0.02	0.01	–0.04	–0.01	–0.01	0.01	–0.03	–0.01
X→M	–0.11	0.03	–0.17	–0.06	–0.11	0.03	–0.17	–0.06
M→Y	0.22	0.04	0.14	0.29	0.09	0.04	0.02	0.17
• Identification of new possibilities	–0.03	0.01	–0.05	–0.02	–0.03	0.01	–0.05	–0.02
X→M	–0.17	0.07	–0.22	–0.12	–0.17	0.03	–0.22	–0.11
M→Y	0.19	0.14	0.12	0.26	0.18	0.04	0.10	0.26
<b>Inadequate social ties recovery</b>								
Total effect	0.05	0.03	0.01	0.10	0.07	0.03	0.01	0.12
Direct effect	0.07	0.03	0.02	0.12	0.10	0.03	0.05	0.15
Indirect effect	–0.02	0.01	–0.04	–0.01	–0.04	0.01	–0.05	–0.02
• Personal strength	–0.01	0.01	–0.03	–0.01	–0.03	0.01	–0.05	–0.01
X→M	0.12	0.03	0.06	0.17	0.12	0.03	0.06	0.17
M→Y	–0.11	0.04	–0.19	–0.03	–0.24	0.04	–0.32	–0.15

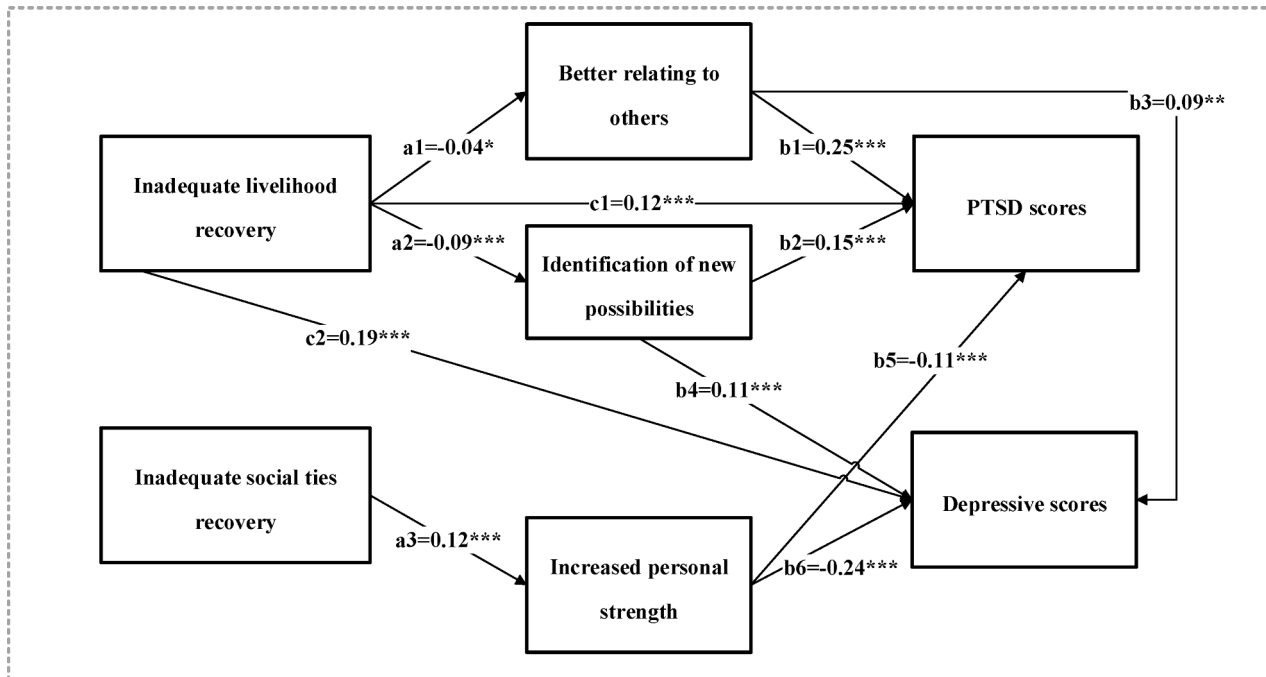
Notes: Insignificant mediating effects weren't presented due to space limitation; All effects have been standardized, and covariates controlled in this test included location, gender, age, marital status, years of education, trauma experience after earthquake and income. Indirect effect of a mediator M =  $\beta (X \rightarrow M) * \beta (M \rightarrow Y)$ .

lower growth in *better relating to others* ( $\beta = -0.04$ ,  $p < 0.001$ ) and *identification of new possibilities* ( $\beta = -0.09$ ,  $p < 0.001$ ), and altered the information and emotion processing in proximal process, thereby buffering the positive effects on mental health outcomes. On the contrary, PTG buffered the positive associations between inadequate social ties recovery and mental health outcomes via *enhanced personal growth*

( $\beta = 0.12$ ,  $p < 0.001$ ). Significant path loadings are displayed in Figure 1.

#### 4. Discussion

This study evaluated the progress of disaster recovery and the levels of mental health outcomes among 1369 adult Wenchuan earthquake survivors 8 years after



**Figure 1.** Path analysis of the associations between inadequate disaster recovery and mental health outcomes by PTG mediation.

the event. We evaluated the hypothesis that inadequate disaster recovery was associated with higher levels of PTSD and depressive symptoms, but that these associations were partially mediated by PTG. Moreover, results indicated that PTG domains mediated the associations between inadequate livelihood recovery and inadequate social ties recovery on PTSD and depressive symptoms differently. These findings shed light on actionable targets for prevention to promote long-term mental health after disasters.

First, this study suggests that disaster recovery hasn't been fully achieved, and inadequate disaster recovery predicts higher risks of mental health outcomes years after the disaster. About 52.2% and 8.1% of the respondents reported unrecovered livelihoods and unrecovered social ties, respectively. Most survivors with these vulnerabilities had repaired their social connections within 8 years after being disrupted, as one prior study had suggested (Leroy et al., 2016). However, reconstruction efforts via subsidies and home rebuilding did not guarantee survivors' livelihood recovery. Most inadequate livelihood recovery was due to unrecovered physical health (44.5% prevalence). Given the association between inadequate disaster recovery and mental health outcomes (Liang, Chu, & Wang, 2014), a wider range of actionable targets that promote long-term disaster recovery should be considered. Moreover, in the Chinese context, inadequate disaster recovery is also associated with higher levels of PTSD and depressive symptoms. As a post-disaster factor (van den Berg, Wong, van der Velden, Boshuizen, & Grievink, 2012),

inadequate disaster recovery not only indicates more disruption from an orderly life and less perceived control (Harms et al., 2015), but also becomes a chronic stressor (Abramson et al., 2008) or a shame (Shimotsu & Horikawa, 2016). In particular, though being less concerned in the face of inadequate livelihood recovery, unrecovered social ties are believed to have a dose-effect and deteriorates mental health together with livelihood threats (Hsueh, 2019). Thus, more actionable targets in promoting long-term disaster recovery should be considered, which have the potential to protect against negative mental health outcomes.

Second, positive associations from inadequate livelihood recovery to mental health outcomes are mediated by decreased growth in *better relating to others* and less *identification of new possibilities*. Following cognitive adaptation theory (Taylor, 1983), the mediation mechanism above could be achieved through two paths, with the first being cognitive-emotional processing. As we observed, survivors with less reported growth in interpersonal relationships and new possibilities are more likely to realize they were vulnerable to disaster. This appraisal provides a mental model consistent with their current unsatisfying situation, positively accommodates the proximal negative emotions, and thus consequently alleviates posttraumatic stress (Joseph & Linley, 2005). In accordance with a previous study, admitting the existence of vulnerability and valuing it as a part of growth is beneficial in bringing mental relief among trauma survivors (Joseph, 2004). The second approach for PTG's mediation observed



in this study is based on information-processing. As noted by the existing study, while the social environment does not support positive adaptation, this information is incompatible to existing schemas, and arouse more stress responses (Creamer, Burgess, & Pattison, 1992). Since resources were depleted in the hardest-hit areas from 2011, and among unrecovered survivors in particular, the social environments may not provide sufficient supports required to improve interpersonal relationships and seek new possibilities. Thus, appraisal of lower growth is helpful in filtering incoming information and reducing incompatible information against existing schemas. Given the implications of PTG in cognitive appraisals, it may be useful to explore during cognitive therapy on posttraumatic stress among those who did not recover their livelihoods, as a previous study noted (Nelson, 2011).

Third, the mediating mechanism underlying associations between inadequate social ties recovery and mental health outcomes included enhanced personal strength. Consistent with an existing study (Peterson, 2014), people may be inclined to compensate their limited social capital with improved positive psychological capital, which is beneficial in stimulating resilience. Greater resilience from enhanced personal strength is possible to mediate the stress responses from two aspects: first, as a positive and stable mental model, personal strength protects survivors from succumbing to catastrophizing or other dysfunctional thinking patterns, and offers them a stronger sense of control over the distress (Bandura, 2012). Second, as the broaden-and-build theory noted (Fredrickson & Joiner, 2002), enhanced personal strength provides people with more powerful strategies in bridging the gap between a less supportive environment and their adaptation needs. Thus, for survivors who were not able to adequately recover their social ties, a focus on enhancing personal strength may be useful to alleviate their stress responses.

Several limitations of this study should be acknowledged. First, this study was cross-sectional in design, which limits causal inference. Although a theoretical framework and empirical evidence were provided to support the mediating mechanism, longitudinal studies are needed that provide additional support to the current findings. Second, the results of this study indicated the relationships between disaster recovery, PTG, and mental health outcomes 8 years after the earthquake. Since considerable time had elapsed since the trauma, further research is needed at more proximal periods during trauma recovery to evaluate whether these associations remain significant. Finally, this study explored PTG's mediating role with parallel multiple mediator models, hypothesizing that all four mediators functioning in parallel. However, if there was a chained process unfolding between mediators (e.g., X-M1-M2-Y), these

could be further examined by multi-step multiple mediator models (See Hayes, 2009). Apart from these limitations, findings in this study provide valuable implications for cognitive therapy and for mental health intervention in the aftermath of natural disasters.

## 5. Conclusion

Survivors of the Wenchuan earthquake did not fully recover from this trauma, and inadequate disaster recovery is associated with higher levels of PTSD and depressive symptoms. Moreover, decreased growth in *better relating to others* and *identification of new possibilities* partially mediate the effects of inadequate livelihood recovery on PTSD and depressive symptoms. Enhanced *personal strength* mediated the positive associations between inadequate social ties recovery and higher levels of PTSD and depressive symptoms. Thus, enhancing disaster recovery is essential for mental health protection, and PTG may be a valuable starting point in cognitive therapy to protect against stress responses after trauma.

## Disclosure statement

No potential competing interest was reported by the authors.

## Data accessibility statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy reasons.

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